Trip Report for ISA MicroCT Installation, Site Acceptance Testing and Training

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Trip Report for ISA MicroCT Installation, Site Acceptance Testing and Training

When: January 6, 2014 through January 16, 2014

Where: Soreq Nuclear Research Facility, Yavne, Israel

Who:

LLNL: William D. Brown and Cary Pincus
Yxlon: Todd Skolnicki
ISA: Ayelet Shapira, Mario Silberman, David Rajsfus, David Rund, Gregory Gershinsky, Yaniv Yakov

Objective:

There were 3 objectives for the trip.

1. Install the ISA MicroCT System
2. Perform System Site Acceptance Testing (SAT)
3. Provide ISA training on the system

January 6, 2014

Ayelet Shapira (ISA) met us at the visitor badge center and escorted us to the location of the ISA MicroCT system. The system was located inside a room sufficiently big to open all access doors and house all peripheral equipment. ISA personnel had not unpacked any equipment and only bolted the system to the floor. The day consisted of installing the x-ray machine, and internal imaging and motion control items. The facility was not wired to provide electricity either for the x-ray machine (220 volts) or the system peripherals (110 volts). ISA personnel scheduled the electrician to provide electricity on January 7. LLNL personnel surveyed the 110 volt items (computers, monitors, motion control, and detector) and found that all items could be run with the building supplied 220 volts 50 Hz and there would be no need for special step down transformers to be added for their use. ISA supplied 220 volt compatible power cords for the peripheral equipment. Details for the x-ray machine and imaging and motion control items are detailed below.

X-ray Machine Installation

The major x-ray machine components (head, generators and power supply, oil cooler, and controller) were packed separate from the shielded cabinet inside crates. The high voltage cables were inserted through the cabinet maze and tied off on the outside (generator side) and the inside (head side). The source mount remained intact inside the shielded cabinet. The crates containing the generator and power supply, tube head, and oil cooler were broken down to allow access to the items. The generators and power supply, and oil cooler were removed from the crates and stationed next to the shielded cabinet. The tube head was stationed in the

tube holder and positioned in the vertical. The height, yaw, pitch and horizontal location of the tube head was placed in the same locations as they were at the Yxlon facility during ISA training in March 2013. The high voltage cables were cleaned, greased, and gapped to both the generators and the tube head. The oil cooler lines were snaked through the maze portal and connected to both the cooler and the tube head. The x-ray controller was attached to the power supply. The system was fully assembled with the exception of the tube head collimator and connection to power. The collimator would be attached after the radiation survey and the power would be attached after the electricians completed their work.

Internal Imaging and Motion Control Components

With the exception of the panel holder and detector which were in crates, all imaging and motion control components were packed in boxes and placed inside the shielded cabinet. The boxes were removed from the cabinet and opened. Each component was removed and checked for visible damage. All components appeared to be in working order. The optical table was left attached inside the cabinet along with the cabling for the detector and motion components. The linear stage, rotation stage that mounts the panel holder and the slit collimator mount were left mounted to the optical table. The references were attached to the carousel and the carousel was mounted to the carousel mounting components. The rotation stage was mounted to the linear stage and the ball alignment phantom was mounted to the rotation stage. Motion control cables were attached to the linear and rotation stages. The slit collimator was mounted to the collimator mount. The panel holder was uncrated and mounted to the manual rotation stage. The 2 – ¼ inch lead shields for the panel were attached to the panel holder. The detector would not be placed into the panel holder until after the radiation survey.

January 7, 2014

The electrician started work to provide electricity to the x-ray machine. The power was provided to the room around noon time. Both computer systems were started and checked for operations. The data acquisition computer was connected to the motion controller system. The stages were checked for homing, proper velocity and acceleration settings, and operation. The Site Acceptance Testing was started. The warm up of the x-ray machine and the SAT are detailed below.

X-Ray System Warm-up

The long warm-up of the x-ray source (mode 103) was started at 2:30 and finished at 4:00 without incidence. A preliminary radiation survey was performed with all readings < 2mr/hr (< 20µSv/hr) at full power (450kV/3.3mA). X-ray system checked out fine and is ready for imaging.

Site Acceptance Testing (SAT)

SAT requirements are detailed in reference [BROWN]. The first part of the SAT is to identify required components and verify they meet the contractual specifications. Most of the system components were identified either before x-ray warm-up or directly after. Some of the motion control components and detector were not identified either because they were inside the cabinet during warm-up or were not completely unpacked. These components will be

identified later. The components identified included computers (2), computer monitors (4), panel holder, carousel, slit collimator, XPS motion controller. All of the identified components met contractual specifications. The second part of the SAT is to demonstrate the functionality of the four doors. All doors worked as specified with the exception of the main electrical door. The door would not close completely without operator intervention and the safety feature that causes the door to open when it is obstructed during closing was not working properly. The Yxlon representative will work on the door January 8. Interlocks, radiation warning lights, emergency stops all function as specified. To finish the SAT we need to identify the motion control components inside the cabinet, fix the electrical door problem, run the source at full power for 30 minutes on each spot, and acquire a CT scan. There are other additional steps to the SAT that will identify imaging characteristics of the system. These are not a requirement for SAT and will be performed after training, time permitting.

January 8, 2014

We started system alignment using the ball phantom and the x-ray radiation survey was performed. We ran a total of 3 CT alignment scans. To finish the alignment, the panel holder and geometry settings (SOD, SDD, ODD) need to be modified to be consistent with the data acquired in March/ April 2013. The radiation survey showed no radiation leaks from the cabinet but the Radiation Safety Officer (RSO) required 2 modifications added to the system. Due to these modifications the system installation and SAT will be delayed. This should have minimal impact for training but may not allow the data acquisition of the SAT optional imaging characteristics. Details of the system alignment and radiation survey are detailed below.

System Alignment

A CT of the ball phantom was run a total of three times. Each run showed the system out of alignment and the alignment software provided output modifications required to get the system into alignment. These modifications included rotating the panel holder in pitch, yaw and roll and also rotating the source around the long axis of the source. To complete the alignment, the panel holder and the geometry (SOD, SDD, ODD) will be modified slightly to provide similar values as the March/April data.

Radiation Survey

The RSO arrived at the facility to conduct the radiation survey. The RSO surveyed all six sides of the enclosure. All radiation values were less than 10 µSv/hr allowed for radiation shielded cabinets in Israel. The largest dose was 5 µSv/hr at the electrical door. The survey was done without the pre-collimator in position. The pre-collimator is located at the tube head port and the collimator function is to keep the detector electronics from being irradiated. During normal operations, the pre-collimator will be in position and the radiation at the door is expected to be less than during the survey. The RSO requested two additions to the cabinet. The first addition is to add a green pre-warning lamp on top of the cabinet next to the blinking radiation “ON” lamp. The pre-warn light will be energized after the x-ray “ON” button is pushed and will extinguish when the x-rays are produced. ISA personnel purchased a green pre-warn light and Yxlon will install. The second addition is a keyed switch in-line with the electric door “OPEN”, “CLOSE” and “STOP” switches. If the 2 interlock circuits both fail as a closed circuit when the

door is opened with the x-rays on, personnel could get an exposure. The RSO wanted the door "OPEN" disabled when x-rays are produced. A keyed switch was purchased and Yxlon will wire the switch such that x-rays can only be produced when the key is switched to the open circuit position and removed from the door switch. The door switch key will be kept on a ring with the x-ray controller key. The x-ray system will not produce x-rays without its key in the controller key switch. The RSO was informed of the suggested approach and agreed this would be adequate. These 2 additions caused a delay in the installation and SAT. This should have no impact on the training schedule.

January 9, 2014

The installation of the RSO requested hardware was completed and the alignment continued. In addition, the components inside the shielded cabinet were identified which completed a portion of the SAT. Details of the hardware installation, system alignment and SAT are detailed below.

RSO Requested Hardware Installation

Yxlon personnel mounted the pre-warn light to the cabinet and strung additional wiring for the light. Once the wiring was completed, the pre-warn circuit was tested successfully. ISA personnel acquired a keyed switch and wired it such that when the key is in the removable position the door "OPEN", "CLOSE" and "STOP" are disabled. When it is in the locked position the door "OPEN", "CLOSE" and "STOP" are enabled. We placed the key on the same key chain as the x-ray control key. After the switch was mounted and wiring completed, the key switch was tested successfully.

System Alignment

We continued the alignment of the source, rotation stage and detector. A number of ball phantom CT scans were performed. After each CT scan the alignment software [DIVIN] was used to provide feedback on the alignment. The software indicates potential changes in the panel holder that are required to get the panel in alignment with the source and rotation stage. After each alignment run, we adjusted the panel holder by the software requested amount and the process will repeat itself until the panel is in alignment. In addition to the alignment of the panel holder, we moved the source and the rotation stage such that the SDD, SOD and ODD were similar values as the March/April 2013 data. At the end of the day, the system was fully aligned.

SAT

We continued the SAT by identifying and verifying the last of the component specifications with the contractual requirements. The components identified were the 2 linear stages and rotation stage housed inside the cabinet. The components met all specifications. The remaining SAT requirement is to acquire a CT scan. This scan will be performed at a later time. In addition, we plan on acquiring image data (MTF, SNR, Dark Noise, etc.) that is requested in the SAT if time permits. This imaging data is not required for the SAT and will be acquired at the end of training.

January 12, 2014

We aligned the slit collimator to the system and began acquiring CT data. Once the system was aligned, the installation of the system completed. The alignment and CT acquisition is detailed below.

Slit Collimator Alignment

We moved the ball phantom out of the field of view and placed the slit collimator in front of the detector. The slit collimator is machined such that the top slit is placed at the x-ray vertical midline plane and the bottom slit is beveled correctly when the collimator is set 940 mm from the source. We set the distance from the source origin to the collimator to the required distance. We then checked the alignment of the slits such that they are parallel to the rows of the detector. The right side of the collimator (from source to detector) was lower than the left. We shimmed the right side of the collimator with thin sheets of paper until the slits were parallel to the rows of the detector. Next we placed the center of the top slit to the vertical midline plane of the detector (row 1027).

CT Data Acquisition

3 CT data sets (160 kV 2 slit, 100 kV 2 slit, 160 kV 1 slit) were acquired on the ISA system with sugar as the sample. The CT techniques used for each acquisition is included in Appendix 1. From the alignment software output, new ISA reconstruction scripts were developed and the 3 data sets were reconstructed using the scripts. A quality check of the reconstructed images was performed and all images appeared acceptable. The 3 reconstruction scripts are included in Appendix 2. With the successful CT data acquisition, the required parts of the SAT were completed. The system passed all required SAT requirements.

January 13, 2014

LLNL began the ISA MicroCT training of the ISA personnel. In addition to the previously trained ISA personnel (Ayelet Shapira, Mario Silberman, David Rajsfus), two additional ISA personnel (David Rund and Gregory Gershinsky) attended the training. The training began with an overview of the system. We discussed the components and functionality of the system including the x-ray machine, staging, detector, slit collimator, carousel, alignment phantom, and x-ray shielded cabinet.

After the overview, LLNL trained ISA personnel on the operation of the MicroCT system hardware. This included training on the warm-up of the x-ray system, changing energy and flux values, interlock safety operation of the x-ray system and operation of the electrical door and safety features of the door.

After completion of the x-ray machine and door training, we began the data acquisition training. The data acquisition training included an overview of the acquisition software and acquisition of 100 kV and 160 kV calibration files. We trained the ISA personnel on acquiring a full data set of 160 kV 2 slit (Exp1), 100 kV 2 slit (Exp2) and 160 kV 1 Slit (Exp1_Open) experiments. The sample used for the training was water.

The water data set was transferred to the reconstruction computer. An overview of the IMGREC software was provided which included reading and writing image and image sequences, simple image processing techniques, acquiring statistics of an image or ROI of an image. After the overview, LLNL trained the ISA personnel on how to reconstruct data from raw projection using IMGREC. LLNL introduced the use of scripts to automate the reconstruction process. ISA personnel used the scripts to reconstruct the water data set. LLNL showed ISA how to review the reconstructed images for quality and how to discern potential centering and beam hardening artifacts.

January 14, 2014

Training continued with review of the Copper Strip and reference/sample analysis software. New data acquisition software was used for data acquisition during alignment and training. This software was incompatible with the Copper Strip software and LLNL reverted back to the software that was used for the original training and system QA acquisition (March/April 2013). Since the installation, LLNL has developed a new acquisition software that is compatible to the Copper Strip software. LLNL is waiting for required US Department of Commerce paperwork from ISA before shipping the new software.

During a power outage the motion control may lose location parameters of the turntable and linear stage. LLNL provided training on a cold start initialization of the motion controller and checking/resetting the motion control parameters after a power outage.

The ISA team acquired a data set using KNO_3 for the sample. All 3 experiments (Exp1, Exp2, Exp1_Open) were executed. The ISA team also executed the Copper strip and reference/sample analysis software.

January 15, 2014

LLNL provided training on CT data acquisition for alignment using the ball phantom and the alignment software. The training included what constitutes a good alignment and if the system is not aligned what procedure needs to be done to get the system in alignment. The output of the alignment software is presented in Appendix 3. A full data set was acquired using H_2O_2 as the sample and the Copper strip and reference/sample analysis software was executed on the data.

January 16, 2014

ISA personnel operated the system with no LLNL intervention. ISA personnel acquired two full data scans with rice being one sample and coffee grounds being the second sample. ISA personnel executed the Copper Strip and reference/sample analysis software. The reference/sample software reported an error on the coffee sample and did not complete. We expect the problem was due to the low attenuation value for the coffee. Isaac will fix this bug in the program and after it is validated, LLL will ship the new software to ISA.

Miscellaneous Items

Because of the lost time to install the inline door switch, pre-warn light and the inability to provide training on the morning of January 14, we were unable to acquire the flat panel characterization part of the SAT. The characterization part of the SAT was not a requirement and did not affect the SAT results.

A number of action items were recorded during the installation and training. A List of these actions is included in Appendix 4. LLNL will complete these actions and report the completions to DHS and ISA.

References

[BROWN] Brown, William D. and Chuck Divin, *Site Acceptance Testing Procedure for ISA MicroCT System*, LLNL-TR-XXXXXX, December 2013

[DIVIN] Divin, Chuck, *MICROCT: Procedure for Alignment*, LEDP-MCT-SOP-010, Dec. 2012

Appendix 1
ISA MicroCT Technique Sheets

Title	160 kV 2 Slit Al/Cu Filter - exp1
System Information	
Data Acquistion Date	Monday, January 13, 2014
System	ISA 450kV
Archive Directory	C:\ISA System\CT Data\2014_Jan_SAT
Source	
X-ray Source	Yxlon 450kV D11
Effective Spot Size (mm)	Small 0.4
Energy (kV)	160
Tube Current (mA)	4.35
Geometric Unsharpness (mm)	0.112
Filter (Type/Thickness mm)	Al/2.0 Cu/2.0
Detector	
Detector Type	Amorphous Silicon Perkin Elmer
Source-Detector-Distance (SDD) (mm)	1413.4
Source-Object-Distance (SOD) (mm)	1103.8
Object-Detector-Distance (ODD) (mm)	309.6
X-Offset (Pixels)	309
X-Size (Pixels)	1694
Y-Offset (Pixels)	995
Y-Size (Pixels)	255
Magnification	1.280
Frame Average(s)	6
Integration Knob-Thales Only	N/A
Integration Time per Frame(sec)	1.15
Raw Pixel Size (mm)	0.2
Global Resampling	1
Effective Pixel size at Detector (mm)	0.2
Effective Pixel size at Object (mm)	0.156
CT Parameters	
Numbers of Views	401
Angular Range	200.5
Angular Step (Degrees)	0.5
Estimated PxCenterFull Panel (Pixel)	1023.1
Estimated PzCenterFull Panel (Pixel)	1027.8

Title	100 kV 2 Slit Al Filter - exp2
System Information	
Data Acquistion Date	Monday, January 13, 2014
System	ISA 450kV
Archive Directory	C:\ISA System\CT Data\2014_Jan_SAT
Source	
X-ray Source	Yxlon 450kV D11
Effective Spot Size (mm)	Small 0.4
Energy (kV)	100
Tube Current (mA)	7
Geometric Unsharpness (mm)	0.112
Filter (Type/Thickness mm)	Al/2.0
Detector	
Detector Type	Amorphous Silicon Perkin Elmer
Source-Detector-Distance (SDD) (mm)	1413.4
Source-Object-Distance (SOD) (mm)	1103.8
Object-Detector-Distance (ODD) (mm)	309.6
X-Offset (Pixels)	309
X-Size (Pixels)	1694
Y-Offset (Pixels)	995
Y-Size (Pixels)	255
Magnification	1.280
Frame Average(s)	6
Integration Knob-Thales Only	N/A
Integration Time per Frame(sec)	0.267
Raw Pixel Size (mm)	0.2
Global Resampling	1
Effective Pixel size at Detector (mm)	0.2
Effective Pixel size at Object (mm)	0.156
CT Parameters	
Numbers of Views	401
Angular Range	200.5
Angular Step (Degrees)	0.5
Estimated PxCenterFull Panel (Pixel)	1023.1
Estimated PzCenterFull Panel (Pixel)	1027.8

Title	160 kV 1 Slit Al/Cu Filter - exp1_Open
System Information	
Data Acquistion Date	Monday, January 13, 2014
System	ISA 450kV
Archive Directory	C:\ISA System\CT Data\2014_Jan_SAT
Source	
X-ray Source	Yxlon 450kV D11
Effective Spot Size (mm)	Small 0.4
Energy (kV)	160
Tube Curren t (mA)	4.35
Geometric Unsharpness (mm)	0.112
Filter (Type/Thickness mm)	Al/2.0 Cu/2.0
Detector	
Detector Type	Amorphous Silicon Perkin Elmer
Source-Detector-Distance (SDD) (mm)	1413.4
Source-Object-Distance (SOD) (mm)	1103.8
Object-Detector-Distance (ODD) (mm)	309.6
X-Offset (Pixels)	309
X-Size (Pixels)	1694
Y-Offset (Pixels)	495
Y-Size (Pixels)	755
Magnification	1.280
Frame Average(s)	6
Integration Knob-Thales Only	N/A
Integration Time per Projection(sec)	0.267
Raw Pixel Size (mm)	0.2
Global Resampling	1
Effective Pixel size at Detector (mm)	0.2
Effective Pixel size at Object (mm)	0.156
CT Parameters	
Numbers of Views	401
Angular Range	200.5
Angular Step (Degrees)	0.5
Estimated PxCenterFull Panel (Pixel)	1023.1
Estimated PzCenterFull Panel (Pixel)	1027.8

Appendix 2
ISA MicroCT Reconstruction Scripts

```
! Recon Script for ISA Exp 1, 160kV 2-Slits
! For data acquired after January 12, 2014,
!
! start with clean signal stack
!
delete 99
!
rdsct exp1
set exstart 50
set eystart 26
set exsize 40
set eysize 10
mkatrad
rdsq atenrad 0
sqext 78 0 1270 255 atenrad
!
rdsct atenrad
set nrays 1270
set nslices 255
set rxelements 1270
set ryelements 1270
set rzelements 255
wrsct atenrad
!
rdsct atenrad
!
makesino 26 36
set pord 5
set npreord 60
set prthresh 0.003
set rngnorm 0
set rth1 0.03
set ord1 7
set dor1 1
set rth2 0.57
set ord2 21
set dor2 1
!set bmcorfile
!set dobm 1
!
ringo
Set pxcenter 636.25
cbp
!
```

```
rdsct atenrad
makesino 215 225
set pord 5
set npreord 60
set prthresh 0.003
set rngnorm 0
set rth1 0.03
set ord1 7
set dor1 1
set rth2 0.57
set ord2 21
set dor2 1
!set bmcorfile
!set dobm 1
!
ringo
Set pxcenter 636.25
cbp
!
!Reconstruction Complete !!!
```

```
! Recon Script for ISA Exp 2, 160kV 2-Slits
! For data acquired after January 12, 2014,
!
! start with clean signal stack
!
delete 99
!
rdsct exp2
set exstart 50
set eystart 26
set exsize 40
set eysize 10
mkatrad
rdsq atenrad 0
sqext 78 0 1270 255 atenrad
!
rdsct atenrad
set nrays 1270
set nslices 255
set rxelements 1270
set ryelements 1270
set rzelements 255
wrsct atenrad
!
rdsct atenrad
!
makesino 26 36
set pord 5
set npreord 60
set prthresh 0.003
set rngnorm 0
set rth1 0.03
set ord1 7
set dor1 1
set rth2 0.57
set ord2 21
set dor2 1
set bmcorfile C:\CT\bmcorfiles\131203_ISA_BHC_Coeffs.txt
set dobm 1
!
ringo
Set pxcenter 636.25
cbp
!
rdsct atenrad
makesino 215 225
set pord 5
set npreord 60
```

```
set prthresh 0.003
set rngnorm 0
set rth1 0.03
set ord1 7
set dor1 1
set rth2 0.57
set ord2 21
set dor2 1
set bmcorfile C:\CT\bmcorfiles\131203_ISA_BHC_Coeffs.txt
set dobm 1
!
ringo
Set pxcenter 636.25
cbp
!
!Reconstruction Complete !!!
```

```
! Recon Script for ISA Exp 1_open, 160kV 1-Slit
! For data acquired after January 12, 2014
!
! start with clean signal stack
!
delete 99
!
rdsct Exp1_Open
set exstart 50
set eystart 50
set exsize 50
set eysize 50
mkatrad
rdsq atenrad 0
sqext 78 0 1270 755 atenrad
!
rdsct atenrad
set nrays 1270
set nslices 755
set rxelements 1270
set ryelements 1270
set rzelements 755
wrsct atenrad
!
rdsct atenrad
set pord 5
set npreord 60
set prthresh 0.003
set rngnorm 0
set rth1 0.03
set ord1 7
set dor1 1
set rth2 0.57
set ord2 21
set dor2 1
!
ringo
!
makesino 715 725
rdsct sinos
Set pxcenter 636.25
cbp
!
rdsct atenrad
fltrads
!
```

```
set ryelements 50
set rzoffset 0
set rzelements 400
set pxcenter 636.25
set pzcenter 532.0
set ryoffset 700
feldkamp
set ryoffset 750
feldkamp
set ryoffset 800
feldkamp
set ryoffset 850
feldkamp
set ryoffset 900
feldkamp
set ryoffset 950
feldkamp
set ryoffset 1000
feldkamp
rdsq recry 700
sqgty 0 400 rz
!
! Reconstruction Complete
```

Appendix 3
MicroCT Alignment Output

```
==== Date ====
File, D:\ct\data\1-15-14BallPhantom14\BallPhantom.sct
Date, 15-Jan-2014 12:01:44

====  Optional Perkin Elmer Corrections ====
X micrometer,   -0.000"
Y micrometer,   +0.001"
Rotate Z,        0° 2.0' CW direction  ( +0.03°)

==== Residual Error in Phantom Projection ====
Elapsed time,    1.4 s
Full RMS err,    0.04 px
Imgrec RMS err,  0.05 px

==== Alignment Parameters ====
Parameter,  Starting Guess, Imgrec Fit,  Full Fit
SOD,              1107.500,  1103.800 ,  1103.800  mm
ODD,               321.800,   309.623 ,   309.623  mm
SDD,              1429.300,  1413.423 ,  1413.422  mm
Px,                1023.10,   1023.07 ,   1023.06  px
Pz,                1027.80,   1027.80 ,   1027.80  px
Pitch (Rx),          0.000,     0.000*,     0.002  degrees
Roll  (Ry),          0.003,    -0.000*,    -0.003  degrees
Yaw   (Rz),          0.000,     0.000*,     0.033  degrees
Phantom x0,          0.000,     0.000*,     0.000* mm
Phantom y0,          0.000,     0.395 ,     0.395  mm
Phantom z0,         -2.691,    -2.693 ,    -2.694  mm
Phantom Rx,          0.000,    -0.000 ,    -0.001  degrees
Phantom Ry,          0.000,     0.020 ,     0.021  degrees
Phantom Rz,          0.000,     0.136 ,     0.136  degrees
   (*) denotes a value fixed during fitting process

==== Residual Error ====
  Full fit to data (px)
         ,   Spec.,  Measured
    Peak:,   2.500,  0.140,     <-Good
     RMS:,   0.500,  0.037,     <-Good

  Full fit to ImgrecFit (px)
         ,   Spec.,  Measured
    Peak:,   0.250,  0.038,     <-Good
    Mean:,   0.100,  0.013,     <-Good

  Imgrec fit to data (px)
         ,  Measured
    Peak:,   0.154
     RMS:,   0.050

==== Settings ====
checkDZ, 0
```

checkDY, 0
checkDX, 1
checkPhantomTilt, 0
checkPhantomSlant, 0
checkPhantomSkew, 0
checkTilt, 0
checkSlant, 0
checkSkew, 0
checkPz, 0
checkPx, 0
checkODD, 0
checkSOD, 0
checkWriteFitToSCT, 0
checkReadROIOnly, 0
checkTrustSCT, 0
checkNumBall, 0
checkIgnoreOccluded, 1
checkRotateClockwise, 1
checkPanelTranspose, 1
filepathText, D:\ct\data\1-15-14BallPhantom14\BallPhantom.sct
statusText, Proccessing Frame 179
Results, char [0 x 0]
AnglesRange, 360
PhantomTilt, 0
PhantomSlant, 0
PhantomSkew, 0
DZ, -2.691
DY, 0
DX, 0
Tilt, 0
Slant, 0
Skew, 0.003
Pz, 1027.8
Px, 1023.1
ODD, 321.8
SOD, 1107.5
TolPeakErrToImgrec, 0.25
TolRMSErrToImgrec, 0.1
TolPeakErrToData, 2.5
TolRMSErrToData, 0.5
TolObjHeight, 52
TolObjMaxRadius, 90
DisplayUpdateStep, 1
NumRefinementIterations, 0
CylinderRadius, 96.2876
BallSpacing, 5
NumBall, 40
SegWindowWidth, 100
SegMaxHshift, 70
SegBallDiameter, 21
SegAreaMin, 45
SegContrastMinPercent, 20
YLeverArm, 400
XLeverArm, 240

```
PixelPitch, 0.2
StartProjection, 0
EndProjection, 150
radioUseAllProjections, 1
radioUseFrom, 0
uselsnonlin, 1
usestats, 1
```

Appendix 4
Action List

Action Number	Completion Date	Status	Responsible Organization	Action
1	31-Jan-14	Completed	LLNL	Add "Update Filename Prefix in Line 8 of the Reconstruction Scripts"
2	31-Jan-14	Completed	LLNL	Update the Data Acquisition Checklist
3	14-Feb-14	Completed*	LLNL	Carousel Alignment pin is broken. Need to acquire and send to ISA.
4	31-Jan-14	Completed	LLNL	Update TP85 with updated scripts and QA Bounds
5	15-Mar-14	Completed*	LLNL	Update the Data Acquisition Softawre to work with the Cu Strip Software
6	1-Jun-14	Active	LLNL	Fix the low attenuation bug in the Reference/Sample analysis software

* These will be shipped to ISA after we receive required US Department of Commerce paperwork from ISA